CALIFORNIA FISH AND GAME

"CONSERVATION OF WILD LIFE THROUGH EDUCATION"

Volume 34 San Francisco, April, 1948 Number 2

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San Francisco, California

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California Fish and Game

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VOLUME 34 ISSUED APRIL 30, 1948 No. 2

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CALIFORNIA'S FISH SCREEN PROGRAM[1]

By J. H. Wales
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In October, 1945, the Bureau of Fish Conservation of the California Division of Fish and Game was given charge of fish screens in the many water diversions of California outside of the Central Valley Project area where the Bureau of Marine Fisheries is working out protection for migrating salmon. Because most of the existing screens were in the Klamath River drainage and because the greatest fish losses were in the irrigation and mining ditches of this region it was decided to establish a fish screen headquarters in Yreka, Siskiyou County (Fig. 12). In the winter of 1946 a warehouse and shop were erected and the present Stream

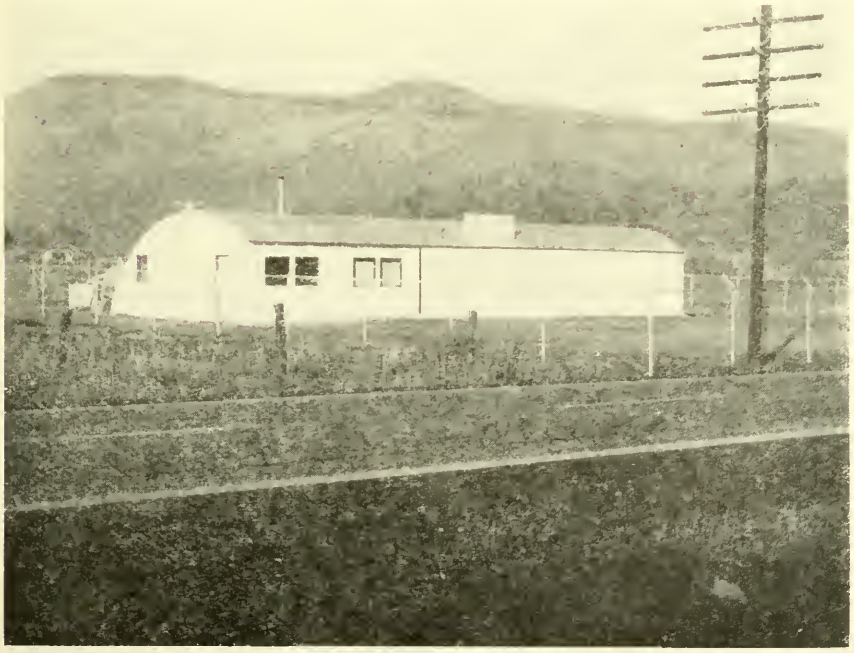

Figure 12. Headquarters of Stream Improvement Detail, Yreka, California

Improvement Detail began to take shape. The plans for 1948-49 call for an eight-man crew with an increase in this number as future needs may require. Already the work shop is fairly well equipped and as soon as additional tools and materials are available the Yreka headquarters will be able to build all of the screens necessary for the northern area and to give these screens the care which they require.

[1] Submitted for publication December, 1947.

Fish screens, like automobiles, have not always been as mechanically satisfactory as they are now. Screens were being installed in the ditches of California before the turn of the century. They bore little resemblance to the screens of today. Between the installation of the first screen and those being built in 1948 there have been nearly as many new designs as there have been new models of automobiles. Each screen has been an improvement over the earlier one and each coming year will probably see improvements in design.

As of December, 1947, there are ninety-one operating screens in the following Northern California counties:

Siskiyou—57; Trinity—30; Shasta—4.

In past years fish screens were often installed in relatively unimportant diversions. At the present time there are many screens located in ditches near the headwaters of streams where the numbers of fish are small. If all such ditches were screened and these screens given the care which they must have, a very large crew of men would be required and far more money would be needed than the number of fish saved would justify. It is necessary, therefore, to weed out the unimportant ditches so that the highly important ones may be properly screened.

The exact number of fish screens which we shall eventually operate is unknown but the accompanying map shows 98 which should be installed in the Klamath drainage alone. The plan is to give immediate attention to ditches where thousands of young steelhead and salmon are lost each year. The job of selecting the most destructive ditches and then installing screens will take some time. However, this job will be done as rapidly as possible. When the most important ditches are screened other ditches of less importance will be cared for until screens have been installed in those irrigation and mining diversions where the losses of fish are sufficiently heavy to warrant the cost of screening.

Fish screens are expensive; their costs range from about $700 to $1,500 for medium sizes and several times that for the largest. A screen for a ditch carrying 1 cubic foot per second of water will naturally be far less expensive than one for a ditch with 10 c.f.s flow. Attempts are being made to develop less expensive screens but our first consideration is efficiency in preventing the young steelhead and salmon from migrating down the ditches. If the building and maintaining of screens were inexpensive then we would place them in every water diversion whether the loss of fish were 100 or 100,000 a year, but in view of the high costs of construction and of maintenance we are forced to restrict our screening to ditches where the losses of fish are heavy, and hope that some day in the future we can afford to screen the less important diversions as well.

All too often the cost of screen maintenance is disregarded. The initial expense of installing the screen is far from being the last. In fact maintenance is a very large part of the total cost of the fish screen program. This is not surprising when we know that for 100 screens four men would be required in maintenance alone. It is a 1,000 mile circuit from the headquarters in Yreka to all of the Klamath drainage screens. Each screen should be visited 20 times a year: during four months of the downstream migration once a week (16 visits), and during the remaining eight months one visit every other month (four visits). The

following costs are those which would be necessary to maintain 100 fish screens in the Klamath Drainage:

Personnel—4 fish hatchery assistants @ $2,400	$9,600
Traveling expenses—4 men at $700 per man	2,800
Transportation—2 trucks @ $600 (10,000 miles @ 6c)	1,200
Screen replacements and repair (100 screens @ $20)	2,000
Total annual cost	$15,600

It was stated earlier in this article that at the present writing there are 91 fish screens now in operation in Siskiyou, Trinity and Shasta Counties. The accompanying map, Fig. 13, will show the location of

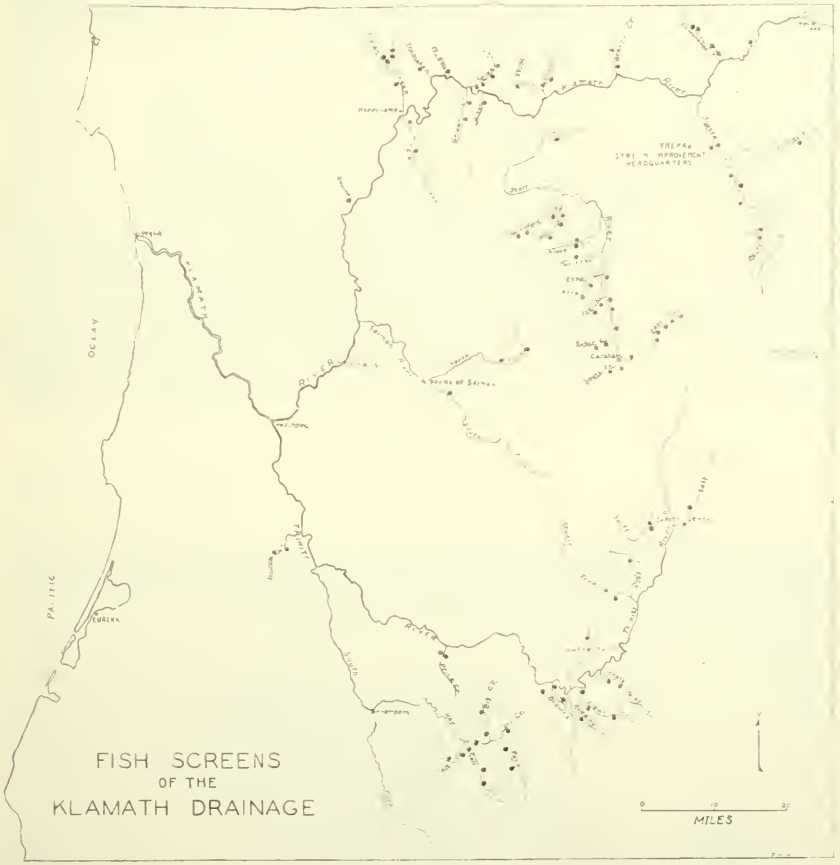

FIGURE 13. Fish screens in the Klamath River drainage. Semi-diagrammatic representation of screens in operation (black dots) or soon to be installed (dots with cross lines).

the tributaries of the Klamath drainage on which screens are located. These are the side streams used by large numbers of spawning steelhead and salmon. Most of the spawning occurs in the period November to March. The eggs require a month or longer to hatch; then the fry remain in the gravel for a similar length of time so that two or three months

elapse between spawning and the emergence of the young fish from the gravel of the stream beds. Most of the young salmon and many of the young steelhead start downstream soon after they come up from the gravel. Part of these early migrants drift down the tributary streams and out into the main river before the irrigation season starts, but even larger numbers are still in the tributary streams when the ranchers start to irrigate in April or May. These young fish are the ones that are so very apt to swim down an irrigation ditch and into a ranch field instead of going down the main stream to the river.

There are very few irrigation ditches which take water out of the Klamath and Trinity rivers themselves; very largely, they divert out of the tributaries to these rivers so that once a fingerling or yearling fish has reached the main river it is comparatively safe from the farmers' fields.

Far more fish are lost down the irrigation ditches during the period March to July than during the remainder of the year. It is necessary that the screens be operating as soon as water is turned into the ditches in the spring for that is the time of the heaviest downstream migration of young fish. Although the peak of the migration is over by July there are many fish which continue to come down during the remainder of the year. For some unknown reason the spawning in certain tributaries is later than in the majority. For example the very young steelhead are drifting downstream in Beaver Creek, a tributary to the Klamath River, in large numbers in September when the migration in most other streams is long past.

Early in the article it was pointed out that fish screens have been slowly improving from year to year. Many screens now operating in California are of outmoded design. They fail to stop a large part of the small fish and they are frequently breaking down and clogging. These old screens must be remodeled or completely replaced. Fig. 14 illus-

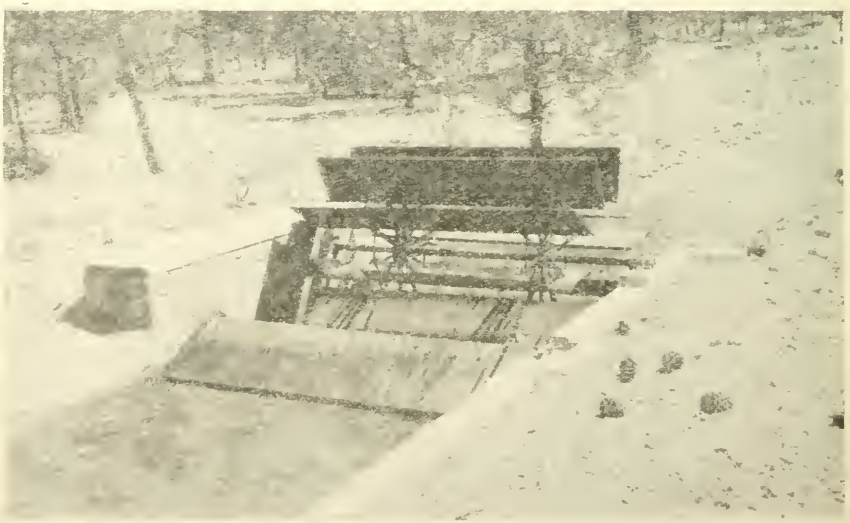

FIGURE 14. Example of bar type fish screen now being replaced by the rotary or revolving type

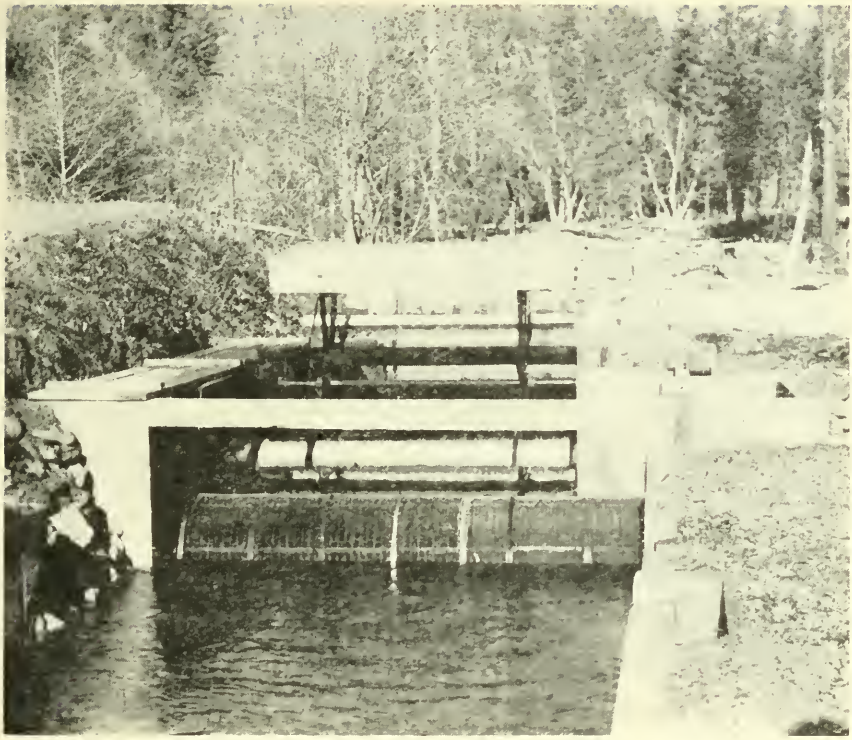

FIGURE 15. Rotary type fish screen recently installed on Beaver Creek

trates the old "bar type" screen which is far less satisfactory than the present day rotary shown in Fig. 15. A large part of the work of the stream improvement crew is replacing these old fashioned screens. A crew of four men will be needed to replace outmoded screens and those that have been destroyed by floods, and to install new screens in ditches that previously had none.

The rotary screen shown in Fig. 16 was unsatisfactory until it was covered by a smaller mesh and until a by-pass was provided. Prior to 1947 these rotary screens were covered with a wire mesh with $\frac{1}{4}$ inch by 3 inch openings. Small fingerlings can easily slip through such large spaces but when the same screen drums were covered by wire mesh with only $\frac{1}{8}$ inch by $1\frac{1}{2}$ inch spaces the fish were stopped.

All of the new type rotary screens are equipped with by-passes. Experiments conducted in 1947 proved conclusively that these by-passes are essential to conduct the young fish back to the stream. These small changes in the screen and in the by-pass have more than doubled the efficiency.

In order to determine just how well the fish screens were operating the Division of Fish and Game carried on an investigation in 1947. Traps were set in the ditches, above the screen, below the screen and in the by-passes, in order to find out the number of fish which the screens were saving. Rotary screens were tested with $\frac{1}{4}$ inch mesh, with $\frac{1}{8}$ inch mesh, with by-passes open and with by-passes closed. Some very surprising

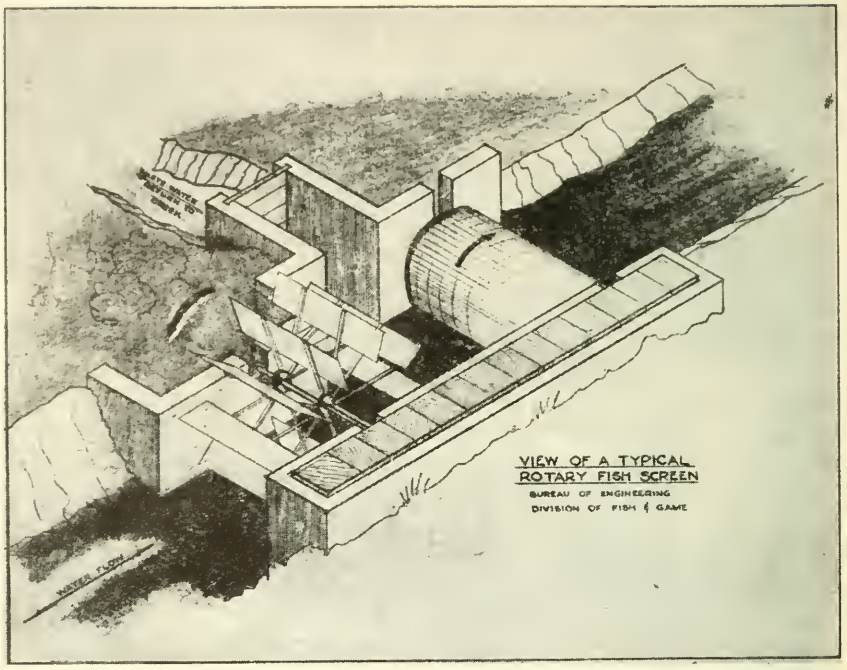

FIGURE 16. Sketch of rotary screen. Certain important modifications have recently been made in this design

and very valuable data were obtained. We found that as many as 5,000 young steelhead went down one ditch in a single night. We found that in other irrigation ditches less than a dozen fish would descend in an entire season. We found that the movement of young steelhead into most ditches began in April or May, quickly reached a peak then rapidly dropped again so that in August there was only a dribble of fish descending the ditches.

The investigation proved beyond a doubt that the $\frac{1}{4}''$ x 3″ wire mesh formerly used on the screens was quite inadequate but that when it was replaced by $\frac{1}{8}''$ x $1\frac{1}{2}''$ mesh the fish were stopped. Perhaps one of the most valuable points highlighted by the investigation was that some water must be allowed to escape through a by-pass. This fact cannot be stressed too much. As one can see in Fig. 16 the flush gate used for "waste water" and to wash out sand and debris is just above the screen. If a small hole is cut through this gate just below the surface of the water the fish will escape through it and find their way back to the stream. If there is no escape hole in this flush gate then the fish will either find their way through the screen mesh or fight the current until so weak that they are carried over the revolving screen with the sticks and leaves. It isn't necessary to by-pass a large volume of water through this hole; about 1/10 of the ditch flow is ample, but this small flow makes the difference between success and failure. At the present time the farmer is not required to by-pass any water at the screen and in most cases there is

considerable opposition to such a so-called "waste" of water. However, if we are to save these hundreds of thousands of steelhead and salmon, by-pass openings must be maintained at all screens. A solution to this problem might be a compromise with the ditch owners whereby the State will assume certain responsibilities in exchange for by-pass water. This would appear to be one of the critical points upon which rests the success of the fish screen program.

The Klamath drainage is not the only one where screens are needed. Throughout the range of the steelhead and salmon there are irrigation ditches, some of them screened but many more that are not. The very large diversion canals of the Central Valley are being protected by electrical and mechanical screens installed by the Bureau of Marine Fisheries of the California Division of Fish and Game. The other coastal streams may not present quite as serious problems as the Klamath and the Sacramento-San Joaquin systems but the ditches diverting water from them will be screened if necessary.

Throughout the inland stream systems inhabited by nonmigratory fishes the need for screens is rarely great enough to justify their expense. Some so-called "nonmigratory" trout do move up and down stream a little and a few can be found in almost any diversion ditch but the cost of installing and maintaining screens is so great that it is financially impossible to take care of the less important ones. However, if tests proved that certain of these ditches are killing large numbers of fish then screens could be installed.

USE AND EFFECT OF EXPLOSIVES IN CALIFORNIA COASTAL WATERS[1]

By John E. Fitch and Parke H. Young
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California Division Fish and Game

Introduction

For many years the discovery of oil deposits in this country has not kept pace with the ever-increasing demands of a mechanical era. World War II hurried the process of depletion of our oil wealth and the outlook for the future is not very bright unless vast new oil fields are discovered and developed. This search for new deposits of oil has taken the oil researchers into the waters off our coast, and the methods employed in the exploration for the oil-bearing geological formations under the sea have resulted in the destruction of various forms of marine life. The total effect of this destruction is not known. In an attempt to throw more light on this problem the Bureau of Marine Fisheries, California Division of Fish and Game, has closely observed the operations of the oil companies engaged in geophysical survey work in our coastal waters. In addition, a limited amount of research has been done on the effect of underwater explosions on some marine animals (Aplin, 1947). The solution of the entire problem does not lie in prohibiting seismic work, but rather in so regulating seismic activities as to hold destruction of our marine resources to a minimum.

Methods

Seismic Operations

Geophysical survey work, as carried on in our coastal waters, entails the setting off of an explosive charge which is destructive to marine life. Most of these operations to date have been carried on between Laguna Beach and Point Conception, from the shore line to five miles offshore. To obtain accurate records, it is necessary for the geophysicists to set off charges of explosives[2] approximately every 250 to 1,000 feet on predetermined lines running north and south and east and west. The sound waves from the explosion travel down through the various strata of rock, and as they bounce back from these strata they are picked up by a number of geophones floated on the surface. An electrical impulse generated by the sound waves then passes from the geophones along a cable to the survey ship, where a permanent record is made on light-sensitized photographic paper. These graphs are later worked out in detail in the offices of the exploring company and anticlinal structures located accurately in various areas of the ocean floor.

The weight of explosive in a single shot has varied from 10 pounds to 160 pounds. In most instances the weight of each individual charge was 40 or 80 pounds for "open" shots and 20 pounds for "jet" shots.

[1] Submitted for publication December, 1947.
[2] Sources of energy, other than explosives, have not as yet been found adaptable to marine seismic operations.

Charges floated a few feet under the surface and exploded from that position are referred to as open shots while those buried under the floor of the ocean by means of a water jet are referred to as jet shots. A third type of shooting, where the charge lies directly on the bottom of the ocean, is also used but not frequently enough to be more than mentioned in passing.

Determination of Destruction

Surface Observations

When an explosion takes place in the water the number of fish killed depends upon the number present in the area. Most of the data collected by the authors concerns only those fish which floated to the surface when killed. Fish which are killed by an explosion, if they are going to float, will come to the surface within 15 minutes. Therefore, surface observations were not made for longer than a 15-minute period after a shot in any one area. The method of determining the number of fish killed and floating in an area was to count a group of 10, 25, 50 or 100 and divide the whole floating mass by inspection into like numerical groups. The above method of counting proved reliable within 10 percent when checked against an actual pickup count.

Weights of the fish killed were determined either by weighing individuals or by picking up 10 to 25 specimens of the small fish, weighing these, obtaining an average weight and applying this average weight to the estimated number of dead fish.

Bottom Samples

During March, 1947, while a geophysical survey was in progress in the Newport-Huntington Beach area and for a week after the cessation of exploratory work, the Bureau of Marine Fisheries received numerous complaints from live bait fishermen that many pounds of dead and rotting fish were taken in their bait hauls. The fishermen attributed this to the seismic operations and insisted that more killed fish sank than floated.

To determine the validity of these complaints attempts were made to find some means of determining the number of fish which were killed and did not float. On April 30, 1947, the Macco Corporation, then operating in the Santa Barbara area, made their survey boat the "Polaris" and a professional diver available for a survey of the bottom where three jet shots had just been made. The "Polaris" was anchored directly over the position where each shot had been fired and the diver searched the bottom for dead fish. The water depth was around 30 feet and there was 100 feet of air hose attached to the diver so the area searched covered about a 75-foot radius around the blast center. At the second position Fitch put on the diving suit and searched the bottom, finding but one small salt-water perch *(Brachyistius frenatus)*. The Macco diver went down immediately after and recovered five perch in the same area. The numbers of fish floating and on the bottom in these three areas are given in Table 7.

Later bottom sampling has been done with the aid of a dredge designed and built by Mr. H. M. Davis of the Kerckhoff Marine Laboratory, Corona del Mar. Most of the work with this dredge has been at depths in excess of 150 feet. The results discussed under "Total Fish Killed" are not conclusive as yet.

Effect on Marine Life

The largest fish observed killed by a shot was a 365-pound black sea-bass *(Stereoleopis gigas)* and the smallest were larval anchovies *(Engraulis mordax)*. The greatest estimated quantity killed as a result of one explosion was approximately two tons of rockfish *(Sebastodes)* but there have been numerous times when not a single fish was killed in a whole day's operation.

Force of an Explosion

The damage that occurs to fish life is, at the present time, thought to be largely limited to those species possessing an air bladder. There is a dearth of factual information on this subject, but what little has been found in the literature confirms our observations. Post mortem examinations of a large number of fish, recovered from both the surface and from the ocean floor, show similar effects. Invariably there is a rupture of the air bladder, and, depending upon the distance and position of the fish in relation to an explosion, other parts of the viscera may be damaged or crushed. In some of the larger fishes the ribs have been broken from the backbone.

The ability of an underwater explosion to inflict damage decreases inversely as the cube of the distance. A fish 10 feet away from an explosion will receive approximately eight times the force from the shock wave as a fish 20 feet from the same explosion. A fish 200 feet from the explosion will receive but one eight-thousandths the shock received by a fish 10 feet distant.

Physical Effect on Fish

The great speed of the shock wave, approximately 4,940 feet per second (Gowanloch and McDougall, 1944), exerts terrific pressure on a fish that presents a broad surface to the direction of wave travel. If the hapless fish is provided with an air bladder, the effect may be fatal. However, when the fish does not possess an air bladder, controlled experiments (Aplin, 1947) showed that there was no noticeable effect. When a fish is either pointed directly toward or directly away from the source of the shock, the pressure exerted will tend to be equal, or very nearly so, on both sides of the fish. Under this condition, recovery from an explosion would tend to be more assured than for fish which are broadside to the path of the shock pressure wave. Fish presenting a broadside are literally plastered up against an incompressible wall of water. The body wall and air spaces within the fish are compressed instantaneously, allowing no opportunity for physiological adjustment to the sudden pressure.

There is, in each species of fish, an inherent resistance to shock pressure. Some species, as the barracuda, kingfish, queenfish and others, possess a tough, heavy-walled air bladder and a body of cylindrical proportions. Such fish appear to have much more resistance to pressure than do laterally compressed fish with a very thin walled air bladder such as the salt-water perch. Jack smelt, although cylindrical in shape, have a thin air bladder and are quite susceptible to blasts. The various rockfishes, which are also quite susceptible, are good examples of fish that have large air bladders with medium thick walls.

Susceptibility Among Mammals

On at least three occasions California sea lions *(Zalophus californianus)* were killed but California grey whales *(Rhachianects glaucus)* observed in the region of a blast were seemingly unaffected and in fact were not even frightened from the area.

The professional diver employed to jet the charges into the bottom by the Macco Corporation was lowered into the water 500 feet from an exploding jetted charge. He stated that he heard a sharp noise in his metal headgear but felt no pain in any part of his body. At a distance of approximately 5,000 feet from an open shot he stated the noise hurt his ears and that he also felt sharp pains in the region of the groin. These pains did not persist or recur.

Susceptibility Among Birds

Among the birds that follow the operations to feed upon the dead fish, the cormorants *(Phalacrocorax)* suffer the heaviest damage because they dive beneath the surface. All appear to be killed if they are below the surface when a charge is exploded. California brown pelicans *(Pelecanus occidentalis californicus)* are frequently killed, but only when they have their heads beneath the surface reaching for a fish. A few gulls *(Larus)* have suffered broken wings after being struck by the column of water which rises in the air when an open shot is exploded. On one occasion a Phalarope *(Phalaropus)* was observed with a broken wing immediately after a shot.

Susceptibility Among Fish

It as been observed many times that not all of the fish within the lethal range of the exploded charge are killed or even outwardly affected by the concussion. Several times in the kelp beds (Santa Barbara area) when a charge was exploded, small perch *(Brachyistius frenatus)* spun and gyrated crazily in the water whereupon kelp bass *(Paralabrax clathratus)*, evidently attracted by these flashing cripples, began feeding upon them and in a few minutes the area was spotted with feeding kelp bass. Succeeding shots in the same area resulted in the death of some of these bass, but, regardless of this, the feeding activities of those unharmed continued.

On another occasion, outside the kelp beds in open water, the observation boat was stopped well within the lethal range of the ensuing explosion. A school of 30 to 40 jack smelt *(Atherinopsis californiensis)* was observed a few feet away from the boat and between it and the charge of explosive. When the blast went off, three, and only three, of this group immediately turned over and floated to the surface. The rest of the school swam off as if nothing had happened.

Similar occurrences have been witnessed often enough to remove any doubt that they may be accidental. However, much more work should be done on the susceptibility of fish to an explosion before drawing any conclusions as to why some are apparently unaffected while others in the same group are killed immediately.

Behavior of Fish

The case of the kelp bass feeding upon the small perch is one example of a case where the fish were not driven from the area by the explosion.

FIGURE 17. Column of water from 80-pound charge of explosives. Water-taxi which set off charge is 43 feet long. *Photograph by John E. Fitch*

The attraction in this instance evidently was food. Aplin (1947) relates an incident concerning a school of anchovies circling the survey ship while blasting was being carried on. The following examples offer further proof that fish are not always driven from an area where dynamite is exploded.

Off Newport on March 25, 1947, shots were fired on the bottom at approximately five minute intervals in one spot marked by an anchored buoy. A few kingfish *(Genyonemus lineatus)* and queenfish *(Seriphus politus)*, both highly susceptible to explosions, were killed with each shot. However, on the eighth shot approximately 350 pounds of barracuda *(Sphyraena argentea)* were killed and floated to the surface. It

will be noted that this was a full 45 minutes or more after the first shot had been fired and not much over five minutes since the preceding explosion.

On one occasion while fishing with hook and line on the bottom in approximately 60 feet of water, two California halibut *(Paralichthys californicus)* and 13 kingfish were caught in 25 minutes succeeding a blast in the identical spot over which the explosion had taken place. Fishing experiments carried on over a period of several days gave even further evidence that the above occurrence was not an accident, as sharks, rays, flatfish and kingfish were caught quite frequently.

It was observed numerous times that when explosions were repeated in an area within a 24-hour period an entirely different group of fishes was killed the second day. Since the fish referred to as killed the second day were for the most part scavengers, it is open to conjecture as to whether or not they had moved into the area to feed on the fish left dead on the bottom from the previous day's operations. One instance of this occurred near Rincon Point on the morning of May 27, 1947, when a charge was fired in the same spot at which a shot the previous afternoon had killed kingfish, queenfish and anchovies. However, besides kingfish, queenfish and anchovies on May 27, approximately two hundred pounds of midshipmen *(Porichthys notatus* and *P. myriaster)* were killed. These had their bellies distended with small kingfish, queenfish and anchovies in various stages of digestion. Since the midshipman is not known to be a schooling fish and since the usual shot kills but one or two midshipmen at the most, it might be assumed they had concentrated in the area to feed upon those fish left dead the day before.

The same thing has happened a number of times where rockfish were killed the second day. Here, too, stomach contents showed all those killed to have been feeding heavily on kingfish, perch, queenfish, sardines and anchovies presumably left dead the previous day. The stomach contents of any large group of rockfish killed in a previously unsurveyed area consisted mainly of small octopi and crabs with empty stomachs predominating.

The extensive observations that have been made during past months give no indication that fish are frightened from an area by a blast. An investigator in Canada (Knight, 1907) observed, "nor could it be said in our experience that pollock *(Pollachus virens)* were frightened away."

Total Fish Killed

Surface Observations

A record of the estimated quantity of fish killed as a result of geophysical survey work conducted on days when an observer from the Bureau of Marine Fisheries was present is given in Tables 1-6. Tables 1, 2 and 3 present data on fish killed by open shots in the Newport Beach region, Santa Barbara region, and Santa Barbara to Gaviota area. Tables 4 and 5 summarize data on fish killed by jet shots in the Newport Beach and Santa Barbara regions. Table 6 contains a summary of all fish killed by all methods.

During the period of this study jet shots killed an estimated 0.23 pound of fish per pound of explosive used and 4.93 pounds of fish per shot. On the other hand, open shots killed 0.47 pound of fish per pound of explosive, double that of jet shots, and 31.56 pounds of fish per shot;

more than six times that recorded for jet shots. This represents 41,000 pounds of fish killed by open shots and 1,000 pounds killed by jet shots. Jack mackerel comprised over 21,000 pounds or one-half of the total. Next heaviest kill was 6,000 pounds of rockfish, which is about one-fifth of the total poundage. Sardines, kingfish and perch fall in line behind these. Aplin (1947) found in his observations that the kill of fish averaged 200 pounds per shot. Our records show only 32 pounds. The difference between these two figures is possibly due to more stringent regulations by the Division of Fish and Game which now prohibit operations in any area except when the fish population is at a low level.

FIGURE 18. Small rockfish (*Sebastodes paucispinis*) floating after a 40-pound charge detonated at four feet beneath the surface. Such destruction is the exception. *Photograph by John E. Fitch.*

TABLE 1

Pounds of Fish Observed Killed by Open Shots in the Region of Newport Beach

Locality and date	Depth of water feet	Number of shots	Total weight of shots pounds	Pounds of fish killed												
				Jack Mackerel	Rock-fish	Sar-dine	King-fish	Perch	Barra-cuda	Pacific Mackerel	White Sea-bass	Queen-fish	Ancho-vy	Jack Smelt	Miscel-laneous	Total
Huntington Pier, March 4, 1947		9	240				1,000					50	50	100		1,200
Off Newport Jetty, March 5, 1947		13	260										5	10		15
Balboa, March 6, 1947		34	870				500					25	20	25		570
Santa Ana River, March 7, 1947		26	420				25			75			10	10		120
Newport, March 10, 1947		2	40				10									10
Newport, March 13, 1947		30	600				20						5	5		30
Newport, March 14, 1947		29	600				25					5				30
Newport, March 15, 1947		16	500													none
Newport, March 17, 1947		no record					10						5			15
Newport, March 18, 1947		no record								50						50
Newport, March 19, 1947		no record														none
Newport, March 20, 1947		32	700													none
Newport, March 21, 1947		1	20													none
Newport, March 22, 1947		10	200				5							10		15
Newport, March 25, 1947	on bottom	15	1,080				25		300			10				335
Newport, March 28 and 29		6	120													none
Newport, March 30, 1947		5	100				20					5		10		35
Totals		228	5,750				1,640		300	125		95	95	170		2,425

TABLE 2

Pounds of Fish Observed Killed by Open Shots in the Santa Barbara Region

Locality and date	Depth of water feet	Number of shots	Total weight of shots pounds	Pounds of fish killed												
				Jack Mackerel	Rock-fish	Sar-dine	King-fish	Perch	Barra-cuda	Pacific Mackerel	White Sea-bass	Queen-fish	Ancho-vy	Jack Smelt	Miscel-laneous	Total
San Augustin, April 16, 1947		4	160		33			396						25	[a]48	502
Naples, May 1, 1947		12	480	870	18	5		440	15					65	47	1,460
Naples, May 14, 1947		2	80		1			1						1		3
Naples, May 15, 1947		15	600	40	10		20	25							5	100
Naples, May 27, 1947		no record					27	2				5				34
Naples, May 28, 1947		no record			1		125	50				25	10		[b]204	415
Isle Vista, June 25, 1947		11	440	521	306		16	39			4			8	26	920
Isle Vista, June 26, 1947		6	140		4		23	3						2	17	49
Tajiguas, July 9, 1947		23	920	195	96		17	158		14				12	29	521
Tajiguas, July 10, 1947	60′ av.	9	360		28		10	93						22	36	189
Totals		82	3,180	1,626	497	5	238	1,207	15	14	4	30	10	135	412	4,193

[a] Includes 38 pounds of kelp bass.
[b] Includes 200 pounds of midshipman.

TABLE 3

Pounds of Fish Observed Killed by Open Shots in the Area Between Santa Barbara and Gaviota

Locality and date	Depth of water feet	Number of shots	Total weight of shots pounds	Pounds of fish killed											
				Jack Mackerel	Rock-fish	Sar-dine	King-fish	Perch	Barra-cuda	Pacific Mackerel	White Sea-bass	Queen-fish	Ancho-vy	Jack Smelt	Miscel-laneous	Total
Elwood, September 9, 1947	60 and over	15	680	906	11	1,073	75	67				5	2	173	[c]4	2,316
Hope Ranch Beach, September 10, 1947	"	11	520	110	3	45	10	34				5		10		217
Hope Ranch Beach, September 11, 1947	"	26	1,770	3,152	185		17	236	40	60	180	5		10		3,885
Goleta Point, September 16, 1947	124-192	17	1,440	105	68	15	50	10					10		[d]45	303
Goleta Point, September 17, 1947	115-195	19	1,600	50	509	20	300	25					10		15	929
Goleta Pt. 1 mi. E., September 18, 1947	100-192	26	2,080	108	31	7	122	33		6		6		11	1	325
Goleta Pt. 2 mi. E., September 19, 1947	103-177	23	1,840	822		2,580	1	1		20						3,424
Gaviota, September 23, 1947	25	1	40				1							7	1	9
Gaviota, September 24, 1947	100 and over	13	1,040	1,500	2	75	25	10								1,612
Goleta, September 30, 1947	100-192	32	2,560	139	21	8	3	36								207
Gaviota, October 1, 1947	100-215	41	3,280	2,009	5	25	8	19								2,066
Gaviota, October 2, 1947	100-200	65	5,200	2,606	4	63	135	10								2,818
Gaviota, October 8, 1947	100-200	23	1,840	69	1	1	1			25					[c]10	107
Gaviota, October 9, 1947	100-200	12	960	203	25	58	2			33					3	324
Gaviota, 4 mi. SE., October 10, 1947	100-210	69	5,520	2,428	1,400	349	100	15								4,292
Gaviota, 4 mi. SE., October 16, 1947	100-205	47	3,760	66	120	2	53	45				2	1		6	295
Gaviota, October 17, 1947	100-213	60	4,640	80	10		25	8							1	124
Gaviota, 5 mi. E., October 21, 1947	100-225	70	5,600	31	569		9	33	100						1	743
Gaviota, 5 mi. E., October 22, 1947	100-200	37	2,960	124	103		17	11								255
Gaviota, 5 mi. E., October 30, 1947	100+	44	3,520	181	43		18								1	243
Gaviota, October 31, 1947	210-550	50	4,000		2,202										[c]51	2,253
Goleta, November 6, 1947	100-220	75	6,000	353	50	35	23	87		240					2	790
Goleta, November 7, 1947	100-200	20	1,600		5			40							[f]40	85
Goleta, November 13, 1947	200 and over	37	2,960	2,250	8	250	250	250							4	3,012
Goleta, November 14, 1947	50	2	160		15			10				5		5	1	36
Goleta, November 20, 1947	10-35	8	640				10	80				25		40		155
Hope, November 21, 1947	40	15	1,200				5	110			1	187	10	30	[g]93	436
Gaviota, November 24, 1947	100 and over	55	4,400	908	1		85	5	133		207		2			1,341
Gaviota, 5 mi. E., November 25, 1947	200-550	19	1,520	550	5										[c]10	565
Gaviota, November 26, 1947	100-210	54	4,320	386	105		146	64	328		82		10		1	1,122
Totals		986	77,650	19,136	5,501	4,606	1,491	1,239	601	384	470	240	45	286	290	34,289

[c] Hake.
[d] Includes 30 pounds of herring.
[e] Saury.
[f] Kelp bass.
[g] Includes 60 pounds of black croaker and one 30-pound black sea-bass.

TABLE 4

Pounds of Fish Observed Killed by Jet Shots in the Region of Newport Beach

Locality and date	Depth of water feet	Number of shots	Total weight of shots pounds	Pounds of fish killed												
				Jack Mackerel	Rock-fish	Sar-dine	King-fish	Perch	Barra-cuda	Pacific Mackerel	White Sea-bass	Queen-fish	Ancho-vy	Jack Smelt	Miscel-laneous	Total
Huntington Pier, March 4, 1947	Under 60	5	100				50						5			55
March 5, 1947	"	3	60													none
March 6, 1947	"	9	140										10	5		15
March 7, 1947	"	12	240				5						10		[b]5	20
March 26, 1947	"	35	700				15						10	5	10	40
March 27, 1947	"	33	660													none
March 28, 1947	"	10	200				20					5	20		[b]136	181
March 29, 1947	"	24	480	20			200					5	125	5	20	375
March 30, 1947	"	22	440				5						10			15
March 31, 1947	"	7	140													none
Totals		160	3,160	20			295					10	190	15	171	701

[b] Grunion.
[c] Includes 125 pounds of sunfish.

TABLE 5

Pounds of Fish Observed Killed by Jet Shots in the Region of Santa Barbara

Locality and date	Depth of water feet	Number of shots	Total weight of shots pounds	Pounds of fish killed												
				Jack Mackerel	Rock-fish	Sar-dine	King-fish	Perch	Barra-cuda	Pacific Mackerel	White Sea-bass	Queen-fish	Ancho-vy	Jack Smelt	Miscel-laneous	Total
More, April 30, 1947	Under 60	11	220		9			77						13	14	113
More, May 1, 1947	Under 60	3	60		3			46						2	16	67
Naples, May 27, 1947	Under 60						23	5				6	20			54
Isle Vista, June 25, 1947	Under 60	7	140		2			18						1	7	28
Gaviota, September 23, 1947	25	2	40					15				10		5		30
Goleta, September 25, 1947	100	3	60					19						4		23
Goleta, September 30, 1947	35	5	200				1	1						1		3
Goleta, November 7, 1947	30	3	120													negligible
Goleta, November 14, 1947	50	7	280					20				5		11	1	37
Goleta, November 20, 1947	20-30	2	80													negligible
Totals		43	1,200		14		24	201				21	20	37	38	355

TABLE 6

Summary of All Fish Killed by All Methods

Region	Number of shots	Weight of shots pounds	Pounds of fish killed												
			Jack Mackerel	Rock-fish	Sar-dine	King-fish	Perch	Barra-cuda	Pacific Mackerel	White Sea-bass	Queen-fish	Ancho-vy	Jack smelt	Miscel-laneous	Total
Table 1, Newport Beach	228	5,750				1,640		300	125		95	95	170		2,425
Table 2, Santa Barbara	82	3,180	1,626	498	5	238	1,206	15	14	4	30	10	135	412	4,193
Table 3, Santa Barbara-Gaviota	986	77,650	19,136	5,501	4,606	1,491	1,239	601	384	470	240	45	286	290	34,289
Totals, Open Shots	1,296	86,580	20,762	5,999	4,611	3,369	2,445	916	523	474	365	150	591	702	40,907
Table 4, Newport Beach	160	3,160	20			295					10	190	15	171	701
Table 5, Santa Barbara	43	1,200		14		24	201				21	20	37	38	355
Totals, Jet Shots	203	4,360	20	14		319	201				31	210	52	209	1,056
Totals, All Methods	1,499	90,940	20,782	6,013	4,611	3,688	2,646	916	523	474	396	360	643	911	41,963

Bottom Observations

Results of the observations made on the bottom during diving operations on April 30, 1947, indicated that the number of fish which do not float is negligible when compared to the number that do float (Table 7). In order to obtain more complete records a dredge has been used in deeper water since November, 1947. In only one instance to date could a direct comparison be made between the number of fish picked up by the dredge, with the number floating. This gave a ratio of about one to one. This is not in accord with the results obtained in the diving operations as shown in Table 7 where the ratio is about twelve floating to one on the bottom. Much more work and experimenting must be done in this line before a true picture can be had of those fish killed which do not float.

TABLE 7

Numbers of Fish Found Floating on Surface Compared With Numbers Found on Bottom

Position	Dead and floating	Dead, recovered from bottom
1	1 Midshipman	6 Saltwater perch
	3 Saltwater perch	
	2 Jack smelt	
	50 small fish taken by gulls	
	56 Total	6 Total
2	3 Rockfish	6 Saltwater perch
	6 Saltwater perch	
	1 Kelp blenny	
	75 small fish taken by gulls	
	85 Total	6 Total
3	1 Kelp bass	17 Saltwater perch
	20 Saltwater perch	2 Kelp blenny
	1 Rockfish	
	2 Pipefish	
	2 Kelp blenny	
	200 small fish taken by gulls	
	226	19

Common and Scientific Names of Fish Killed

1. Anchovy, deep-bodied, *Anchoa compressa*
2. Anchovy, northern, *Engraulis mordax*
3. Barracuda, *Sphyraena argentea*
4. Bass, kelp, *Paralabrax clathratus*
5. Bass, sand, *Paralabrax nebulifer*
6. Blacksmith, *Chromis punctipinnis*
7. Corbina, California, *Menticirrhus undulatus*
8. Croaker, black, *Sciaena saturna*
9. Croaker, spotfin, *Roncador stearnsii*
10. Croaker, yellowfin, *Umbrina roncador*
11. Cusk eel, *Otophidium scrippsi*
12. Cusk eel, *Otophidium taylori*
13. Grunion, *Leuresthes tenuis*
14. Hake, *Merluccius productus*
15. Herring, Pacific, *Culpea pallasii*
16. Kelp blenny, *Heterostichus rostratus*
17. Kingfish, *Genyonemus lineatus*
18. Mackerel, jack, *Trachurus symmetricus*
19. Mackerel, Pacific, *Pneumatophorus diego*
20. Midshipman, *Porichthys myriaster*
21. Midshipman, *Porichthys notatus*
22. Mullet, *Mugil cephalus*
23. Opal-eye, *Girella nigricans*
24. Perch, black, *Embiotoca jacksoni*
25. Perch, fork-tailed, *Damalichthys vacca*
26. Perch, Pacific white, *Phanerodon furcatus*
27. Perch, rainbow, *Hypsurus caryi*
28. Perch, rubberlip, *Rhacochilus toxotes*
29. Perch, wall-eyed, *Hyperprosopon argenteum*
30. Perch, *Brachyistius frenatus*
31. Perch, *Cymatogaster aggregatus*
32. Perch, *Micrometrus minimus*
33. Perch, *Zalembius rosaceus*
34. Pipefish, *Syngnathus californiensis*
35. Queenfish, *Seriphus politus*
36. Rockfish, bocaccio, *Sebastodes paucispinis*
37. Rockfish, chili-pepper, *Sebastodes goodei*
38. Rockfish, green spotted, *Sebastodes chlorostictus*
39. Rockfish, starry, *Sebastodes constellatus*
40. Rockfish, striped, *Sebastodes elongatus*
41. Rockfish, yellow-tailed, *Sebastodes flavidus*
42. Rockfish, *Sebastodes miniatus*
43. Rockfish, *Sebastodes rastrelliger*
44. Rockfish, *Sebastodes rubrivinctus*
45. Sardine, *Sardinops caerulea*
46. Sargo, *Anisotremus davidsonii*
47. Saury, Pacific, *Cololabis saira*
48. Sea-bass, black, *Stereolepis gigas*
49. Sea-bass, white, *Cynoscion nobilis*
50. Shad, *Alosa sapidissima*
51. Sheepshead, California, *Pimelometopon pulchrum*
52. Smelt, bay, *Atherinops affinis*
53. Smelt, jack, *Atherinopsis californiensis*
54. Stickleback, *Aulorhynchus flavidus*
55. Sunfish, ocean, *Mola mola*
56. Whitefish, ocean, *Caulolatilus princeps*

REGULATIONS GOVERNING SEISMIC OPERATIONS

Rules and Regulations

The following rules and regulations were adopted by the California Fish and Game Commission at the meeting on August 22, 1947, and became a part of the Fish and Game Code effective September 19, 1947.

As provided by Section 480, the following are the regulations under which permits are granted to use explosives in the waters of this State inhabited by fish, insofar as such explosives may be used for seismic exploration:

(a) Permits shall be issued for such areas and seasons as will result in a minimum of destruction to marine life and fisheries.

(b) No blasts shall be set off in waters of less than one hundred feet (100′) (seventeen (17) fathoms), except as they are placed below the surface of the ocean floor, unless prevented from so doing by rock formations.

(c) An employee of the Division of Fish and Game shall be permitted to accompany the boat or crew which is conducting the exploratory work, as an observer to determine if any damage is done to the fisheries. This observer shall have the authority to stop operations in any given area if damage to marine life seems too great. A boat and boat crew shall be made available to this observer to check the area after each individual blast, and this boat shall carry, and the crew shall help operate, such gear and equipment as the observer shall furnish, and permittee shall meet any expense of gear rental or operation that may be incurred.

(d) All fish of edible size which may be killed shall be picked up by the operating crew, and arangements made for their free disposal to charitable institutions or agencies.

(e) Anyone holding a permit shall notify the Division of Fish and Game in writing before beginning operations. For operations in San Luis Obispo County and southward, the Terminal Island Office shall be notified; for operations in Monterey County and northward, the San Francisco Office shall be notified.

(f) On the fifteenth and last day of each month of operation, the permittee shall submit a report of dates, location, and number of detonations made in the preceding period. A report shall be submitted for each permit for each half-month period whether operations were actually conducted or not. The report shall include the species and weight of edible fish disposed of, as provided in paragraph (d), and the name of the recipient.

(g) No permit shall be issued for more than ninety (90) days, and no applicant shall be issued more than one permit at a time.

(h) In order to subject the fish life to a minimum of disturbance, no permit shall be issued to any applicant after October 1, 1948, for any area until twelve (12) months after the last previous issuance of a permit for that area to the same or any other applicant, providing such permit was exercised. The provisions of this paragraph do not prohibit the setting of recheck shots not to exceed ten (10) percent in number of those actually fired during the life of the permit. The approval of the commission must be obtained before such recheck shots are fired.

(i) Any permit granted by the Fish and Game Commission to conduct seismic operations grants permission only insofar as the Fish and

Game Commission is concerned. No permit is valid nor shall be exercised unless at the time thereof the permittee has in force and effect a permit covering such operations issued by the State Lands Commission of the State of California.

(j) All permits shall be subject to revocation at any time.

Form of Permit

The following form has been adopted for use in issuing permits by the California Division of Fish and Game to the various companies desiring to do geophysical survey work in California waters:

TO WHOM IT MAY CONCERN:

Permission is hereby granted, insofar as the Division of Fish and Game is concerned, to (*name, address*) to use explosives for seismic work from (*date*) to (*date*), inclusive, from (*location*) to (*location*).

It is understood in this permit that no blasts shall be set off in waters of less than one hundred feet (100′) (seventeen (17) fathoms), except as they are placed below the surface of the ocean floor, unless prevented from so doing by rock formations.

It is further understood that an employee of the Division of Fish and Game shall be permitted to accompany the boat or crew which is conducting the exploratory work, as an observer to determine if any damage is done to the fisheries. This observer shall have authority to stop operations in any given area if damage to marine life seems too great. A boat and boat crew shall be made available to this observer to check the area after each individual blast, and this boat shall carry, and the crew shall help operate such gear and equipment as the observer shall furnish, and permittee shall meet any expense of gear rental or operation that may be incurred.

It is further understood that all fish of edible size which may be killed shall be picked up by the operating crew, and arrangements made for their free disposal to charitable institutions or agencies.

Permittee shall notify the Bureau of Patrol and Law Enforcement, Division of Fish and Game, Terminal Island, California, in writing before beginning operations.

On the fifteenth and last day of each month of operation, the permittee shall submit a report of dates, location, and number of detonations made in the preceding period. A report shall be submitted for each half-month period whether operations were actually conducted or not. The report shall include the species and weight of edible fish disposed of, as provided in paragraph four above, and the name of the recipient.

This permit grants permission to conduct seismic operations only insofar as the Fish and Game Commission is concerned. The permit is not valid and shall not be exercised unless at the time thereof permittee has in force and effect a permit covering such operations issued by the State Lands Commission of the State of California.

This permit is subject to revocation at any time.

Disposal of Fish Killed

To prevent waste of fish, regulations were set up requiring that all edible fish be picked up and turned over to charitable institutions. Although this scheme was considered to be most favorable by all concerned, it did not prove practical since charitable agencies do not have facilities to handle quantities of fish at irregular intervals. As a substitute, all edible fish are disposed of through normal commercial channels. Money from the sale of these fish is being held in trust until enough is accumulated to warrant transfer to charitable agencies. The handling of fish by the commercial establishments has been rotated periodically among the companies willing to handle such material. The amount of fish sold from September 18 to November 27, 1947, comprised 4,110 pounds which realized $218.04 (Table 8).

TABLE 8

Pounds and Value of Fish Sold

Date	Rockfish		Jack & Pacific Makerel		Barracuda		White Sea-bass	
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
1947								
September 18	171	$8 55						
September 23	379	18 95	81	$4 05				
September 25			657	19 71				
October 8	74	2 96						
October 9	35	1 40	69	2 76				
October 22	218	7 63						
October 23	113	3 96						
October 31	1,552	54 32						
November 19			25	75	78	$11 70	30	$4 50
November 24			145	4 35	84	12 60	201	30 15
November 27					198	29 70		
Totals	2,542	$97 77	977	$31 62	360	$54 00	231	$34 65

Conclusions

Constant observations should be continued in order to determine damage to marine life and to improve methods of keeping this destruction to a minimum.

Jetting of shots will substantially reduce destruction. During the period of this study, jet shots killed an estimated 0.23 pound of fish per pound of explosive or 4.93 pounds of fish per shot, whereas open shots killed 0.47 pound of fish per pound of explosive or 31.83 pounds of fish per shot.

Not all fish killed by an explosion float. Some method of determining the number which sink should be devised.

Not all fish susceptible to an explosion and within lethal range of a shot are killed or injured.

Certain birds and mammals are killed by underwater explosions under some conditions.

Fish are not driven from a particular area by underwater explosions.

References

Aplin, J. A.
1947 The effect of explosives on marine life. California Fish and Game, vol. 33, no. 1, pp. 23-30.

Gowanloch, James Nelson, and McDougall, John E.
1944 Louisiana experiments pave way for expanded oil research. Louisiana Conservationist, vol. 3, no. 1, pp. 3, 6.

Knight, A. P.
1907 The effects of dynamite explosions on fish life. Contributions to Canadian Biology, 1907, pp. 22-30.

A REVIEW OF THE SOUTHERN CALIFORNIA SPINY LOBSTER FISHERY[1]

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Introduction

The spiny lobster, *Panulirus interruptus* Randall, a member of the family Palinuridae, ranges on the west coast of North America from San Luis Obispo County, California, southward at least as far as Magdalena Bay, Lower California. In the vicinity of the southern limit of the commercial range its distribution overlaps that of another spiny lobster, *Panulirus inflatus,* commonly known as the pinto lobster, which is said to be very abundant in the Gulf of California.

The family Palinuridae consists of six genera and about twenty species, inhabiting the tropical and subtropical waters of the globe. The most prevalent common names besides "spiny lobster," are "lobster," "crawfish," "crayfish," and "bug." "Langosta" is the Mexican appellation.

Two other lobsters are commercially important in the United States: the American lobster, *Homarus americanus,* and the spiny lobster of Florida, *Panulirus argus.* The California and Florida spiny lobsters are very similar, differing from the American lobster in that they lack the large anterior claws, having no pincers on the first pair of walking legs. The American lobster ranges on the east coast of North America from Labrador to North Carolina, and the Florida spiny lobster ranges from North Carolina southward.

The spiny lobster, (Fig. 19) as its name implies, is covered with a multitude of forward-pointing spines. The most characteristic of these is the pair of large spines projecting forward and curving over the eyestalks. The antennae are heavy and spinous, and are longer than the body in most individuals.

Body coloration varies from dark red to very dark brown. Cooked, the color turns to the bright orange color characteristic of lobsters at the market.

History

One of the first references to the California lobster fishery is by Jordan (1887), who states that in 1879, "One man is engaged in fishing for crawfish, but there is no regular market or price for his catch," in Los Angeles County. Further, "Nearly all of the crawfish sold in San Francisco comes from Santa Barbara. About 90 tons are taken annually. A cannery for the purpose of canning crawfish was started at Santa Barbara in 1877. It failed because the managers did not understand their business properly." Rathbun (1884) states, "When abundant near shore, catches aggregating 500 pounds have been made by a single person in the short space of two hours," and, "Average sized individuals weigh from three and one-half to four pounds." This shows that in the more or less primitive condition of the fishery, lobsters were extremely abundant, and that the average weight was about double that of today.

[1] Submitted for publication December, 1947.

At the turn of the century it had become increasingly apparent that the supply of lobsters was falling short of the demand. Therefore, upon recommendation of the Fish and Game Commission, legislation was enacted to close the season between April 1st and August 15th, to prohibit taking any lobster less than nine and one-half inches in length, and to prohibit taking any egg-bearing female.

By 1909, in spite of the protection afforded, the situation had become so serious that the season was entirely closed for two years, the market being supplied from Mexican sources during that period. With the opening of the season in 1911, the size limit was reduced to nine inches. Lobsters were abundant, and serious gluts on the market occurred, with much waste. In 1913 a maximum size limit of thirteen and one-half inches was imposed, in addition to the nine-inch minimum size limit. In 1917 the present size limits were established at a minimum of ten and one-half inches and a maximum of sixteen inches. Measurement is made from the base of the antennules to the end of the tail. The closed season between March 15th and October 1st has been in effect since 1935.

All the lobster landed in the State of California is utilized in the fresh condition, as pursuant to Section 785 of the Fish and Game Code, "It is unlawful to pickle, can or otherwise preserve any spiny lobster, or to sell any spiny lobster not in the shell." Thus, aside from the small portion sold directly to the consumer by the fishermen, all is purchased and sold by fresh fish dealers. These dealers may sell the lobster alive or cooked, depending upon the condition when landed, distance to be shipped, and desire of the customer. The lobster is cooked in large tanks of boiling water from 15 to 20 minutes. One pound of salt for every 10 pounds of lobster to be cooked is added to the water.

The Fishery

In 1946 a total of 1,917,581 pounds of spiny lobster was landed in the State of California, with a value of $611,000 to the fishermen. In that year the fishery ranked twenty-first by poundage and eleventh by value among the fisheries of the State. Of the 1946 total, 691,814 pounds originated in waters of the State, while 1,225,767 pounds were imported from Mexico. The 1946 landing from California is the largest since records have been kept (Fig. 20).

There are three major regions in California where lobsters are landed: San Diego, Los Angeles, and Santa Barbara. In the Los Angeles region landings are made at many small ports as well as at Los Angeles Harbor. San Diego received 56 percent of the Lobster during the 1946-47 season, Los Angeles region 36 percent, and Santa Barbara 8. San Diego owes its position as the chief lobster port solely to the fact that the bulk of the Mexican imports are landed there. Both Los Angeles and Santa Barbara receive more lobster form California waters than does San Diego.

Gear

There are two basic types of traps or pots in general use, with many variations of each to suit the desire of the individual. They are the lath type and the wire-covered type. The wooden lath type (Fig. 21) is in more general use. It is 36 inches square at the base, and 15 inches high,

FIGURE 19. The California spiny lobster, *Panulirus interruptus*. *Photograph by J. M. Hawthorne*

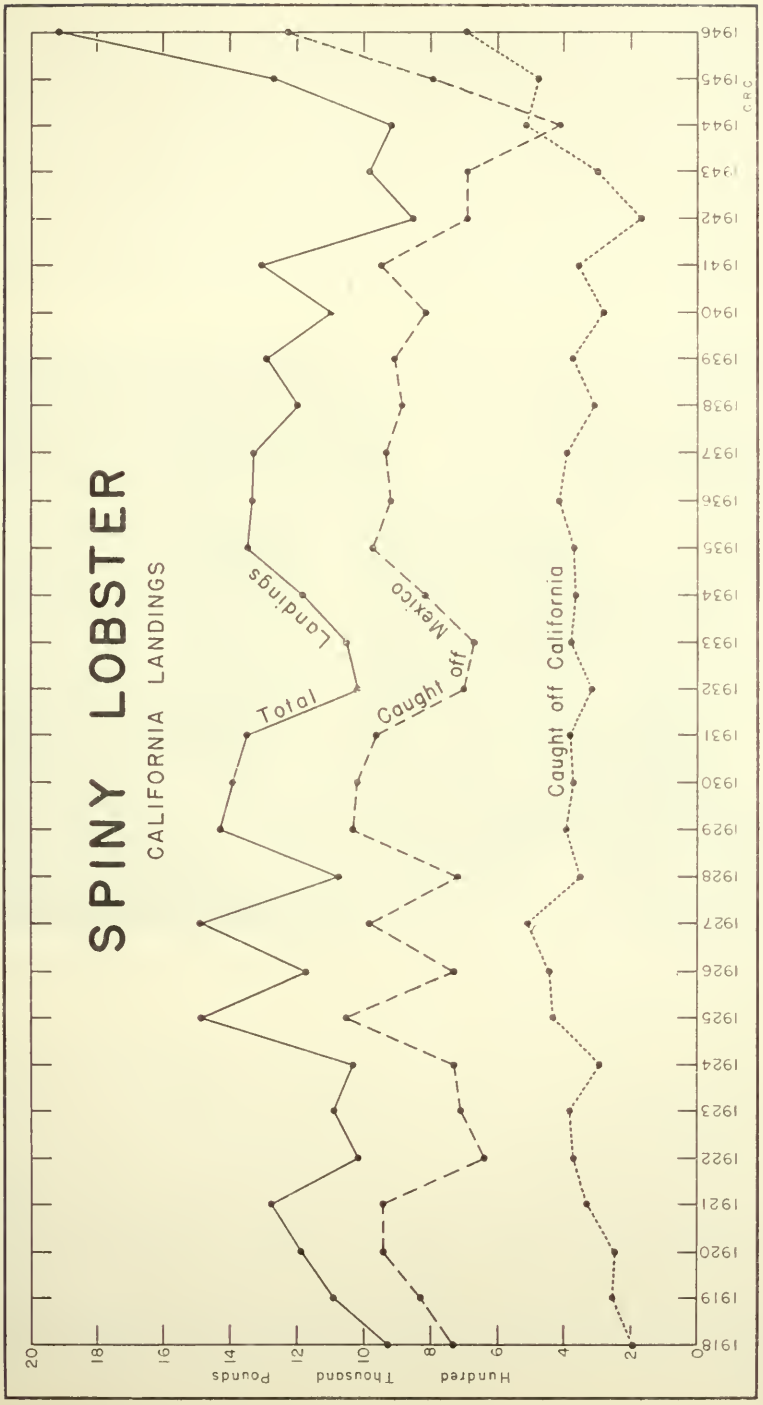

FIGURE 20. California spiny lobster landings, 1918-1946

with slanting sides. The frame is of one-inch by two-inch wood, covered with ordinary wood lath. Weight is provided by concrete poured into frames on the bottom. Usually one opening is provided for entrance of the lobster into the trap. The wooden lath pieces, forming a funnel downward to prevent escape of the lobster, are five to six inches long. The top of the trap is removable, and each end is fitted with a U-shaped piece of rope for making fast the buoy line. Buoys are usually redwood, painted a distinctive color for ready identification by the owner. The buoy line may be fitted with a cork or bottle, which is made fast a few feet above the trap. This keeps the line clear of the bottom, and prevents fouling. Cost of this trap, exclusive of labor, is estimated to be from $4.50 to $6, at 1947 prices.

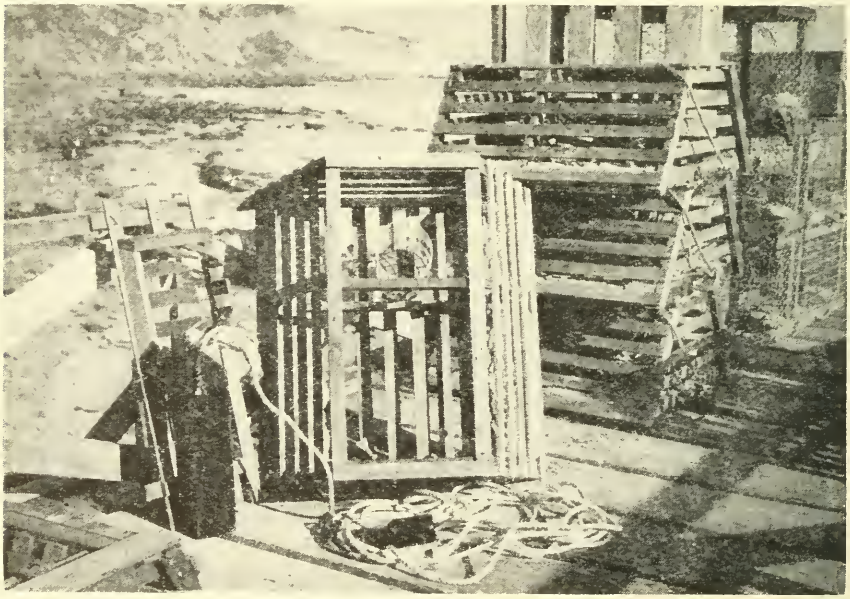

FIGURE 21. A lath type trap with the top removed. Note the cylindrical bait protector in the trap, the black painted buoy at left, and the bottle made fast to the buoy line at lower center. Several of the wire-covered type traps are in the background at the right. *Photograph by John F. Janssen, Jr.*

The wire-covered trap is more expensive, the cost per trap, exclusive of labor, averaging $7 to $10, depending upon the quality of wire netting used. The frame is of one-inch by two-inch wood which is covered with chicken or fox-wire netting. A wire funnel-shaped entrance is provided with a circular opening six to ten inches in diameter at the inner end. As in the wooden traps, weight is provided by concrete, in this case, poured in the corners of the bottom. This trap is generally heavier than the lath type. Fishermen who use this type claim that in spite of increased initial cost, losses to storms are fewer.

Either of the traps may be fitted with a cylindrical bait protector (Fig. 21) to prevent the lobster from consuming the bait after it enters the trap.

Boats

The sizes of boats used in the fishery vary from 15-foot skiffs to power boats 45 feet or more in length. Most of the skiffs used are powered by outboard motors. Crews of skiffs may be one or two men. Ordinarily they fish close to home. The larger boats, with from one to four men, may fish either the coast or the Channel Islands, delivering their catches to one of the three major ports, the choice depending upon convenience and price. Most of the boats fishing along the coast deliver their catches every day. Trips to the Channel Islands may extend to 10 days, the boat remaining on the fishing grounds until a full load can be taken into port. About 40 skiffs are engaged in the fishery, and about 100 boats larger than skiffs fished during more than half the 1946-47 season. Skiff fishermen may operate as many as 75 traps, while the larger boats may fish as many as 200.

Fishing Methods

About a week before the season opens, most fishermen put their traps out on the grounds, unbaited, to "soak them up." This also performs the function of establishing the fisherman's right to the area where the traps are soaking. In some especially intensively fished areas the competition is keen for choice locations.

The most productive lobster areas are on rocky bottom. Most fishing is done in the kelp, which grows on this type of bottom. South of Point Conception, most of the kelp areas are intensively fished for lobster, both along the mainland coast and around the Channel Islands. Santa Catalina Island and Santa Monica Bay are closed by law to lobster fishing.

Upon opening of the season, the traps are baited and fishing commences. Preferred bait is fish heads, although some individuals favor sardines if available. When fish heads are used, they are generally wired to the bottom of the trap, though some place them in the bait protector. Most fishermen have an understanding with the dealer to whom they sell their catch whereby the dealer provides bait. In some areas procurement of bait is difficult, and the fisherman must catch his own.

Customary procedure is to start lifting the traps at daybreak, or soon after. Some fishermen believe that the lobster can and will escape from the trap as it becomes light, and that daylight increases the possibility of invasion of the trap by sheepshead and other enemies. The legal lobsters, if any, are removed, short and oversize lobsters are released, and the trap is baited if necessary before being set again.

If the lobsters are to be sold that day, they are taken into port. If not, they are placed in a live car for storage until such time as they may be marketed. The live car, or receiver (Fig. 22), is a box with a lath top, or of all open lath construction, 36 inches by 20 inches at the base, and 18 inches high. It is moored to a buoy on the surface of the water when in use, and will hold up to 100 pounds of living lobster.

The lobsters are graded small, medium, and large. The large lobsters (known as "bulls") generally do not command as high a price per pound as the small and medium grades.

Many traps are lost each season; sometimes a fisherman may lose his entire string. The chief cause of loss is storms. The storm loss is most heavy to those traps set in shallow water, where the traps are washed

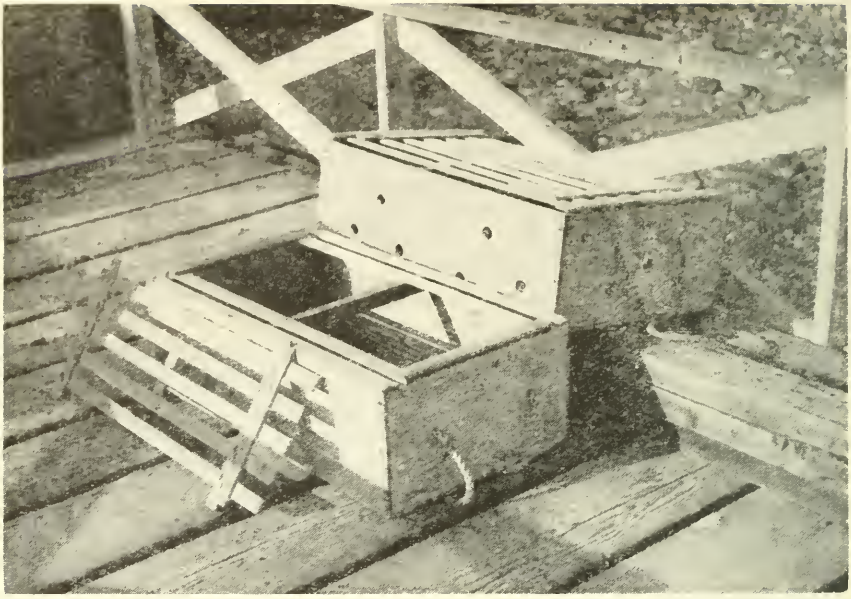

FIGURE 22. Live cars used in the lobster fishery. Note holes in sides for circulation of water. *Photograph by John F. Janssen, Jr.*

into the surf and broken up. Another cause of loss is theft. To avoid this, many fishermen set their traps in strings without buoys, and recover them by use of a grappling hook, or shorten the buoy line so that the buoy is below the surface of the water. Fishermen in the San Diego area complain that the kelp harvester cuts buoy lines as it moves through the kelp beds. There is a possibility that traps thus unrecoverable on the bottom may act as permanent traps, the lobsters in the traps eventually dying and acting as bait for other lobsters, and so on. Conceivably in an area where large numbers of traps have been lost this situation might have a very bad effect on the population.

Not many lobsters are taken in traps by sport fishermen. The lobster season is open only during the cooler winter months, which somewhat restricts the activities of the skin divers, but among those who are active, the spiny lobster is in greatest demand. No record is available of the amount taken by skin divers, but assuredly the figure is not insignificant. One observer estimates that 200 skin divers may be seen on a warm Sunday afternoon during the winter months, from Point Conception southward.

Mexican Importations

Lobster from Mexican waters is brought into this country by boat (Fig. 23), truck, and plane. All are alive when delivered.

Fishing cooperatives have been established in Lower California, and Mexican Government regulations reserve the right to fish most areas of the coast to their members. Americans interested in purchasing lobster may do so by a contract with the cooperatives, which is made in the presence of a Mexican Government representative. The buyer supplies

FIGURE 23. A typical lobster transporter at Ensenada Bay, Lower California. The barrels on deck contain fresh water. *Photograph by G. R. Chute*

the necessary equipment, and lobster camps are established at prearranged localities along the coast. The catch at the camp is sold only to the buyer who established it, at a price stipulated in the contract. The Mexican season extends from October 15th to March 15th. Mexican lobster may be imported into this State only during the open season here.

If the buyer uses boats as means of importation, the boat makes regular trips between camps and market, returning to the camps with supplies and fresh water. Lobsters will stay alive out of the water for about 24 hours, so boats which are loading at camps more than 24 hours' running time from port must stop every day and put the live cars into the water for several hours, to give the lobsters a "drink" (Fig 24).

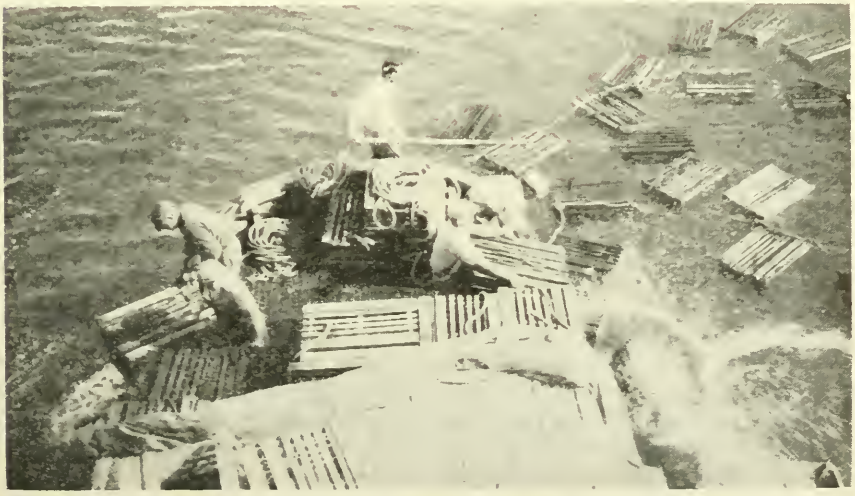

FIGURE 24. Live cars containing lobsters being put over the side for a "drink" en route from Lower California waters. *Photograph by G. R. Chute*

Three drinkings are about the maximum which lobsters can stand without heavy mortality. At present the bulk of imported lobster is brought by boat.

A postwar development is that of importation by air. At present the lobsters are flown to Tijuana, where they are loaded into trucks and brought across the border. Costs of importation by air compare favorably with costs by boat, and this method promises to be of increasing importance.

Biological Notes

Habits

Lobsters are nocturnal in habit, seeking dark crevices in which to hide during the day, and actively moving about the bottom at night. Fishermen claim that lobsters are not very active on moonlight nights, catches being larger during the dark of the moon.

The spiny lobster moves about the bottom on its five pair of walking legs. When frightened or beset by enemies it can move rapidly backward by strong flexion of the tail, using its powerful abdominal muscles and spreading the tail fan while so doing. The easily pivoted antennae are used effectively for defense. The lobster always tries to face the attacker, pointing the antennae so that the forward-pointing spines on the flagellae bear toward the danger. The spiny lobster has many enemies beside man. Among these are the black sea-bass, sheepshead, moray eel, and octopus. Lobsters are known to be cannibalistic, but the extent of this cannibalism is not known.

The spiny lobster is a bottom forager. It is omniverous, but prefers flesh of all kinds. Examination of lobster stomach contents by Allen (1916) revealed broken parts of other lobsters, sponge material, fish scales, and fragments of kelp leaves and other algae. Studies by Fry (ms) show that the lobster uses its heavy mandibles to break open mussel shells, but will not do so when more easily obtained food is present.

If spiny lobsters have a consistent pattern of movement about the bottom, it is not fully understood. Allen (1916) tagged 334 lobsters in the vicinity of Santa Barbara and the Channel Islands. In all, 27 were recovered, and indicated a rather haphazard movement in all directions from the point of tagging. Movement varied from zero miles in 16 days to nine and three-fifths miles in 28 days. Most fishermen believe that the lobsters in general move into deeper water during fall and winter, and return to shallower water in spring and summer.

Growth

No data are available on the rate of growth. Growth is accomplished when the lobster molts or sheds its shell. It is probable that molting occurs the year around, but most frequently in the summer and early fall. No direct method of age determination is known.

To accomplish molting, the carapace becomes disarticulated at its junction with the abdomen and is lifted up in this area. The entire animal escapes through this rupture, leaving in most cases a perfect shell behind. The new shell is quite soft and leathery, and the lobster is inactive for several days while it hardens.

Size

The largest lobsters are believed to reach a weight of over 30 pounds, but individuals over 18 inches in length and six pounds weight are rare. A specimen was taken near San Pedro by a skin diver which weighed 26 pounds. Some unverified reports indicate that a weight of 34 pounds is reached. Allen (1916) compared males and females of the same lengths and showed that the female is not as heavy as the male, the difference increasing with size.

Size at Maturity

Studies of maturity on 360 female lobsters by Fry(ms) showed 90 percent to be mature at a body length of 225 mm. (8.9 inches). He indicates that the males reach maturity at a smaller size than the females.

SEXUAL MATURITY OF 360 FEMALES, LA JOLLA, 1928

Length in mm.	*Length in inches*	*Number mature*	*Number immature*	*Percent mature*
180	7.1			
185	7.3	1	21	4.6
190	7.5	3	38	7.3
195	7.7	9	29	23.7
200	7.9	13	31	29.6
205	8.1	16	17	48.5
210	8.3	40	15	72.7
215	8.5	31	4	88.6
220	8.7	28	3	90.3
225	8.9	19	2	90.5
230	9.1			

Sexual Differences

The adult male may be easily differentiated from the adult female. The fifth walking leg of the female bears a small pincers which is not present on the fifth walking leg of the male. The underside of the abdomen bears four pairs of leaflike structures called swimmerets. Those of the adult female are much larger than those of the male, and each of a pair is biramous, or two-branched, while those of the male are single.

The sex ratio is extremely variable with locality and time. Sex determinations by Allen (1916) on 1,157 lobsters at 12 different times and places resulted in variations of from 34.6 to 80.9 percent female, with an over-all average of 50.5 percent female. Determinations by Fry (ms) at one location (La Jolla) over a period of three months resulted in an over-all percentage of 61.4 female. Determinations by the writer of 482 lobsters at eight different times and places resulted in variation of from 33.3 to 69.6 percent female, with an over-all percentage of 53.3.

Spawning

With possibly a few exceptions, adult females spawn every year. Whether a female might spawn more than once a season is not known. The spawning period is from March to August, with the maximum number of berried female observed about the last of June (Allen 1916).

The male deposits upon the ventral surface of the female's thorax a putty-like mass of sperm material, containing cavities in which the spermatozoa lie. Deposition of the putty is not necessarily simultaneous with extrusion of eggs by the female. How many females one male might

thus serve in a season is not known. In this connection, Fry (ms) states, "The presence of putty on the ventral side of a female's carapace is no evidence of maturity as many immature individuals carry sperm. On the other hand, during the breeding season with the exception of a few who had recently cast their shells, no mature female was found which did not have either putty or evidence of its former presence."

The small coral-red eggs are carried on the swimmerets of the female for about two months before hatching. Female egg production increases greatly with increase in size. One count by Allen (1916) of a fourteen-inch female's eggs totaled approximately 500,000, while an eight-inch female would produce about 50,000.

The young hatch into a leaflike free-swimming larval stage, of which not much is known. Schmitt (1919) states that 14 lots of large and intermediate sized free-swimming larvae and one bottom stage were taken off the California coast in depths up to 75 fathoms, and as far as 150 miles off the coast. Time elapsed before the leaflike free-swimming larva settles to the bottom and metamorphoses into the bottom form is not known. The free-swimming larvae taken at 75 fathoms may indicate that lobsters occur at greater depths than the maximum of 35 fathoms at which they are taken by fishermen, or that larvae which settle in deep water migrate into shallower water.

References

Allen, Bennet M.
1916 Notes on the spiny lobster (*Panulirus interruptus*) of the California coast. Univ. California Pub. Zool., vol. 16, no. 12, pp. 139-152.

Fry, Donald H., Jr.
Unpublished manuscript of work on spiny lobsters at La Jolla in 1928.

Jordan, David Starr.
1887 Part XVI—The fisheries of the Pacific Coast, pp. 596, 601. In the Fisheries and Fishery Industries of the United States, Section II. Washington.

Rathbun, Richard.
1884 Part V—Crustaceans, worms and sponges. In the Fisheries and Fishery Industries of the United States, Section I, p. 781. Washington.

Schmitt, Waldo M.
1919. Early stages of the spiny lobster taken by the boat "Albacore." California Fish and Game, vol. 5, no. 1, pp. 24-25.

OBSERVATIONS ON THE MUDSUCKER, GILLICHTHYS MIRABILIS[1]

The mudsucker or long-jawed goby is one of the most important bait fishes used by sportsmen in Southern California. Bait dealers claim this fish is becoming more difficult to obtain and that the demand for it has increased. Several dealers have attempted to culture them for commercial purposes, but have so far met with no success. During the past year I made a study of the development and breeding behavior of the mudsucker (Copeia, 1947, No. 2, pp. 77-85) and investigated the effects of salinity on their spermatozoa (Physiol. Zool., in print). The practical aspects of these studies are summarized here. It is hoped that this may in part aid in the conservation of the mudsucker and perhaps solve some of the problems connected with their artificial propagation.

The spawning period of the mudsucker in the San Diego area (determined from collected young and examination of adult gonads) extends from January to July with the height of spawning in February, March and April. The number of eggs produced by a female ranges from 4,000 to 9,000, depending on the size of the fish. The eggs have adhesive threads at one end. These are attached to a central stalk from which the eggs dangle. The period of development is 10 to 12 days. The young are unlike the adults in that they are differently pigmented and are small-mouthed and large-eyed, whereas the adults have very long jaws and small eyes.

With a little practice it is easy to differentiate a female from a male. The genital papilla of the female is much broader and has a more swollen appearance. Also the papilla of the female is not so pointed at the end.

In numerous attempts I have never been able to strip eggs from seemingly ripe fish. The protracted breeding period and the probability that the females have but one annual spawning make it difficult to obtain a female which happens to be fully ripe at the time. Also it is possible that there must be a "psychological" stimulus before the eggs are freely released since the mudsuckers pair several days prior to spawning and exhibit courtship behavior which includes the building of a nest. These factors make the mudsucker an impractical fish for artificial rearing.

Active spermatozoa can be stripped from males during the entire spawning period—January to July. The spermatozoa are active in dilutions and concentrations ranging from 17 percent to 200 percent sea water with a salinity of 33.6 grams per kilogram. They are motile longest in 25 percent sea water. The fact that the bays and estuaries inhabited by *Gillichthys* are subject to an influx of fresh water during the period when this goby spawns may be related to the fact that the spermatozoa are longest active at reduced salinity. However, the spermatozoa are well adapted to the environment of normal sea water as they are active from 3–6 hours in this medium. This must certainly provide time enough for the spermatozoa to find and fertilize the eggs.

As the mudsucker is used so extensively for fresh-water bait, it is well to note that their spermatozoa have no motility in fresh water. This renders them a safe fish to use for bait since, though the fish itself can live in fresh water, it cannot reproduce in this medium. There is no likelihood of its being introduced as an undesirable species in lakes and streams.—*George F. Weisel, University of Montana, Missoula, Montana, November, 1947.*

[1] Contributions from the Scripps Institution of Oceanography, New Series, No. 363.

1947 PISMO CLAM CENSUS

The staff of the Bureau of Marine Fisheries made a census of Pismo clams *(Tivela stultorum)* on Pismo Beach on November 28-30, 1947. The results indicate a reduction of 43 percent in numbers of clams on the beach since the 1946 census. The poor 1947 set accounted for the greatest decrease, whereas clams four years and older were 89 percent as numerous as last year. The good set of 1946 produced 38 percent of all clams on the beach in 1947. Of the clams found in the intertidal zone, only 2 percent were of legal size (five inches). A census has been made in 18 of the past 24 years. The methods used and the numbers found were summarized by Aplin (California Fish and Game, vol. 23, pp. 129-131). The numbers of clams found in 1947 in the three cross-sections of the beach are listed below by age-classes.

Age	0	1	2	3	4	5	6	7	Over 7	Total
Number of clams	32	295	101	67	149	90	25	5	8	772

Bureau of Marine Fisheries, California Division of Fish and Game, December, 1947.

LANDINGS OF SARDINES ALONG THE PACIFIC COAST

The sardine industry and government agencies have experienced a need for records of total sardine landings along the Pacific Coast of North America. To make such records readily available, a table has been compiled which shows tonnages landed during the past 32 seasons. The season here used was selected to break the data at that time in the year when there is practically no fishing on any of the grounds and to correspond to the biological year for the sardine. The time interval included in each season is, therefore, from June 1st to May 31st of the following calendar year. The records include deliveries to the fresh fish markets as well as to processing plants.

Data for British Columbia were supplied by the Canadian Bureau of Statistics and the Province of British Columbia, those for Washington by the Washington Department of Fisheries and for Oregon by the Fish Commission of Oregon. Tonnages delivered to the floating plants were compiled by the United States Fish and Wildlife Service from the books of the companies operating off the California coast. California landings were derived from the records of the California Division of Fish and Game. The table does not include tonnages taken by a small fishing fleet operating out of Ensenada and off Cedros Island in Mexican waters.

Every effort has been made to check the figures here presented and it is felt that the table represents the most accurate records attainable. They differ in minor amounts from previously published records due in part to corrections and in part to the use of a sardine season which does not correspond to a calendar or fiscal year.—*January, 1948.*

SEASONAL CATCH IN TONS OF SARDINES ALONG THE PACIFIC COAST—EACH SEASON INCLUDES JUNE THROUGH THE FOLLOWING MAY

Season	British Columbia	Washington	Oregon	Total Pacific northwest	California					Grand total	California percent of total
					Floating plants	San Francisco	Monterey	San Pedro	San Diego	Total California		
1916-17							7,710	17,380	2,440	27,530	27,530	100
1917-18	80			80		70	23,810	41,340	7,360	72,580	72,660	100
1918-19	3,640			3,640		450	35,750	32,530	6,810	75,540	79,180	95
1919-20	3,280			3,280		1,000	43,040	16,580	6,410	67,030	70,310	95
1920-21	4,400			4,400		230	24,960	11,740	1,520	38,450	42,850	90
1921-22	990			990		80	16,290	19,220	910	36,500	37,490	97
1922-23	1,020			1,020		110	29,210	33,170	2,620	65,110	66,130	98
1923-24	970			970		190	45,920	35,040	2,780	83,930	84,900	99
1924-25	1,370			1,370		560	67,310	96,330	8,820	173,020	174,390	99
1925-26	15,950			15,950		560	69,010	61,990	5,710	137,270	153,220	90
1926-27	48,500			48,500		3,520	81,860	64,720	2,110	152,210	200,710	76
1927-28	68,430			68,430		16,690	98,020	67,900	4,650	187,260	255,690	73
1928-29	80,510			80,510		13,520	120,290	119,250	1,420	254,480	334,990	76
1929-30	86,340			86,340		21,960	160,050	140,540	2,620	325,170	411,510	79
1930-31	75,070			75,070	10,960	25,970	109,620	38,490	80	185,120	260,190	71
1931-32	73,600			73,600	31,040	21,610	69,080	42,660	260	164,650	238,250	69
1932-33	44,350			44,350	58,790	18,630	89,600	83,600	60	250,680	295,030	85
1933-34	4,050			4,050	67,820	36,340	152,480	125,050	1,750	383,440	387,490	99
1934-35	43,000			43,000	116,480	69,000	230,860	178,820	4,860	600,020	643,020	93
1935-36	45,320	10	26,230	71,560	150,830	76,150	184,470	138,400	10,650	560,500	632,060	89
1936-37	44,450	6,560	14,200	65,210	235,590	141,100	206,710	138,110	4,590	726,100	791,310	92
1937-38	48,080	17,100	16,660	81,840	67,550	133,720	104,930	109,950	380	416,530	498,370	84
1938-39	51,770	26,480	17,020	95,270	43,890	201,200	180,990	146,400	2,780	575,260	670,530	86
1939-40	5,520	17,760	22,330	45,610		212,450	227,870	101,820	110	542,250	587,860	92
1940-41	28,770	810	3,160	32,740		118,090	165,700	175,590	1,200	460,580	493,320	93
1941-42	60,050	17,100	15,850	93,090		186,590	250,290	148,910	1,580	587,370	680,370	86
1942-43	65,880	580	1,950	68,410		115,880	184,400	201,510	2,870	504,660	573,070	88
1943-44	88,740	10,440	1,820	101,000		126,510	213,620	135,310	2,690	478,130	579,130	83
1944-45	59,120	20		59,140		136,600	237,250	178,290	2,770	554,910	614,050	90
1945-46	34,300	2,310	90	36,700		84,100	145,520	173,110	950	403,680	440,380	92
1946-47	3,990	6,140	3,960	14,090		2,870	31,240	194,720	4,770	233,600	247,690	94
1947-48	490	1,360	6,930	8,780		300	18,770	93,910	2,430	*115,410	*124,190	93

* Preliminary totals subject to minor additions.

FISH CASES

October, November, December, 1947

Offense	Number arrests	Fines	Jail sentences (days)
Abalone: possession undersized; overlimit; out of shell; no license	26	$382 50	10
Angling: no license; more than one line; false statements obtaining license; possession spear; closed waters; night fishing; non-resident license; use of another's license; 150 feet of dam; transferring license; failure to show; after hours; shooting fish	143	1,974 00	2
Bass: possession undersized; overlimit; night fishing; more than one line; failure to show; offer for sale; buying; no license; early fishing	112	3,458 00	6
Catfish: possession undersized; overlimit; two poles	9	185 00	
Clams: possession undersized; overlimit; out of shell; no license; early and late clamming	80	1,615 00	
Cockles: possession overlimit; failure to show; no license	10	175 00	
Commercial: no license; illegal use of gill and drag net; waste of fish; failure to keep and submit records; purse seine district 20A: over size mesh; selling undersized catfish failure to deliver receipts; fyke nets closed district	42	3,335 00	
Crabs: possession overlimit; closed season; failure to keep records	8	375 00	
Chumming: inland waters	2	20 00	
Croakers: round haul net	3	150 00	
Lobster: possession closed season; under sized; over sized; possession district 20	25	902 00	
Pollution: oil	9	2,000 00	
Salmon: possession overlimit; no license; more than one line; snagging; gaffing; closed area; night fishing	62	2,043 00	16
Sunfish: possession overlimit; no license; closed season	29	614 00	
Trout: possession overlimit; closed stream; no license; sale; two lines; night fishing; set lines; chumming	20	545 00	
Seals: shooting	3	75 00	
Game Fish: overlimit	3	50 00	
Totals	586	$17,918 00	39

GAME CASES

October, November, December, 1947

Offense	Number arrests	Fines	Jail sentences (days)
Coots: closed season; using rifle	4	$90 00	
Deer: Forked Horn District 1¾; taking doe; spike buck; spotlighting; overlimit; license other than own; night hunting; killing fawns; use .22 rifle; selling fawn; using steel jacketed bullets; in refuge; possession closed season; possession fawn; improperly tagged; claiming deer belonging to another; illegal hours; no license; no tags	150	15,386 00	368
Deer Meat: illegal possession; doe; unstamped; yearling; spike buck	38	5,413 00	
Deer Tags: possession other than own; failure to validate; failure to fill out and attach; transfer; altering; possession special and regular; failure to carry; "A" tag in one deer district	62	2,405 00	
Doves: no license; early shooting; closed season; overlimit; unplugged gun; no alien license; .22 rifle; overlimit from Mexico	59	1,593 00	3
Ducks: closed season; illegal possession; in refuge; no stamp; no license; night hunting; overlimit; unplugged gun; failure to show; .22 rifle; motor boat; after hours	209	9,812 00	
Frogs: undersized	1	15 00	
Geese: overlimit; late shooting; illegal possession; closed season	29	1,063 00	
Grebe: possession; shooting	2	50 00	
Squirrel: overlimit; no license; possession	7	320 00	2
Hunting: in refuge; spotlighting; night hunting; no license; unplugged gun; late shooting; false statement obtaining license; from motor vehicle; power boat; .22 rifle; metal jacketed bullets; using another's license; transferring license; early and late shooting	502	10,536 00	
Non-Game Birds: shooting from auto; possession	9	260 00	10
Pheasants: closed season; illegal possession; use of rifle; shooting hen; failure to show; overlimit; shooting from tractor; from automobile; in refuge; importing from Mexico closed season	146	8,110 00	
Pigeons: closed season	2	75 00	
Quail: unplugged gun; overlimit; closed season; no license; illegal shotgun; overlimit Mexican	37	1,021 00	
Rabbits: closed season; no license; overlimit; night hunting	22	450 00	
Shore Birds: taking	26	680 00	
Swan: killing	1	25 00	
Fur Bearing Mammals: Bear—closed season; Marten—closed season	4	135 00	
Trespass: in refuge; oyster beds; game management area	10	235 00	
Totals	1,320	$47,847 00	386

SEIZURE OF FISH AND GAME

October, November, December, 1947

Fish:

Abalone	234
Bass	145
Bass, pounds	319
Catfish	54
Catfish, pounds	300
Clams	3,268
Bonito, pounds	115
Crabs	129
Barracuda, pounds	113
Cockles	2,310
Lobsters	305
Lobsters, pounds	500
Sunfish	295
Sunfish, pounds	5
Salmon	62
Salmon, pounds	75
Trout	134
Yellowfin Croaker	20
Yellowfin Croaker, pounds	300
Horse Mackerel, pounds	7,600

Game:

Coots	20
Deer	82
Deer Meat, pounds	1,028
Doves	280
Ducks	687
Frogs	4
Geese	94
Mudhens	17
Non-Game Birds	13
Pigeons	2
Pheasants	101
Quail	27
Rabbits	28
Seagulls	3
Shore Birds	58
Squirrels	21
Bear Meat, pounds	115
Pine Marten	7

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Resolution

WHEREAS, For the past two years the Honorable Lee F. Payne has served the public, the State of California and the Fish and Game Commission as its president faithfully and well, and

WHEREAS, It clearly appears to this commission that the conservation, preservation and protection of California fish and game has greatly been expedited and enhanced during the term of Mr. Payne's administration, and

WHEREAS, This commission desires to express to Mr. Payne its appreciation and thanks for his splendid work and effort in its behalf and in behalf of the conservation of wildlife in California, and also desires to acquaint the public at large and the Governor of this State of such expression;

NOW, THEREFORE, The Fish and Game Commission of the State of California, in regular meeting assembled, does hereby

Resolve:

1. That its thanks and appreciation be and are hereby expressed publicly to the Honorable Lee F. Payne for his interest, time and effort during the past two years in behalf of this commission as its president and in anticipation of his continued efforts on behalf of the conservation, protection and preservation of wildlife in this State, as an active member of this commission.

2. That copies of this resolution be forwarded to the Governor of the State of California, President Lee Payne of the commission, and that additional copies hereof be released to the press and published in all magazines or journals issued by this commission.

Adopted January 10, 1948

Notice of Commission Meetings to Establish Season and Bag Limits on Birds and Mammals

Notice is hereby given that the Fish and Game Commission shall meet on April 9 and 10, 1948, in the California State Building, Los Angeles, to receive recommendations from its own officers and employees, from public agencies, from organizations of private citizens, and from any interested party as to what, if any, orders should be made relating to birds and mammals or any species or variety thereof. On April 29 and 30, 1948, the Fish and Game Commission shall meet in the California State Building, San Francisco, to hear and consider any objections to its determinations and proposed orders made in accordance with Section 16.1 of the Fish and Game Code, such determinations and orders resulting from hearings held on April 9 and 10, 1948.

Motion Pictures Available for Showing

The following motion pictures on fish and game are available for showing to organizations and schools:

"Beaver Management"—1 reel—Sound film—25 minutes. The State's program for live trapping and transplanting beaver.

"More Quail for the Desert"—1 reel—Sound film—55 minutes. Description of how to build quail watering devices and how these improve quail abundance.

"Lure of the Klamath"—Two 400-foot reels—Silent film—20 minutes. Fishing scenes along the Klamath River.

"More Trout for the Creel"—1 reel—Sound film—45 minutes. Description of trout hatchery and planting methods and policies.

"Sardines for Supper"—1 reel—Sound film—45 minutes. Story of California sardine fishing and canning methods.

All films are 16 mm. color. All sound films are on large size reels.

Interested groups may apply to the Sacramento office of the California Division of Fish and Game. In requesting films for showing, be sure to give the preferred dates, where films should be sent, and what, if any, projection equipment is needed. It is sometimes possible to have a speaker accompany the films. This is required where projection equipment is to be supplied by the division. It is advisable to request a date well in advance.

Announcement of Recent Publications

Fish Bulletin No. 66 (1947), Drift and Set Line Fishing Gear in California. By W. L. Scofield. 38 pages, 16 figures.

Fish Bulletin No. 67 (1947), The Commercial Fish Catch of California for the Years 1945 and 1946. By the Staff of the Bureau of Marine Fisheries. 80 pages, 7 figures.

These two publications are available to interested persons by request. Write to:

DIVISION OF FISH AND GAME
California State Fisheries Laboratory
TERMINAL ISLAND, CALIFORNIA